names. Another specimen is from Lanyon, Cornwall, having a black ground with crystals of flesh-coloured felspar, varying from the smallest size up to 2 inches by 1½ inch. This number also includes a beautiful tesselated table composed of fifty-four specimens of polished stones from a porphyry quarry at Retire-in-Withiel.

It is much to be lamented that a material of such high value as granite for all building purposes should, by its enormous cost in London, be placed beyond the reach of all but the most wealthy corporations, and individuals who are compelled to undertake the most imperishable class of buildings. If it were possible to deliver granite in the Thames at something like 2s. 6d. or 3s. per cubic foot, instead of double this price, it would, no doubt, vastly stimulate the consumption of this very superior material, and add greatly to the character of our ornamental buildings. The expensive freight of granite, which is usually sent to London by sea, has hitherto been the barrier to its general introduction, but now that the counties of Devon and Cornwall possess a railway communication with the metropolis, it is not too much to expect so great a reduction in the cost of transport as to bring granite generally into the London market. It appears that the Great Western Railway Company would derive a very handsome profit by carrying up this granite to London, at a cost of 10d. per cubic foot, which would probably effect a saving of several shillings per foot in the price of granite. The same observation applies to the beautiful porphyries of Cornwall, which vary through every gradation, from the highly ornamental crystalline and variegated specimens which adorn the halls of palaces, down to the decomposing and earthy varieties which are scarcely suitable even for road-stone. The finer specimens of porphyry are much used for ornamental flooring, ceilings, columns, pilasters, tables, recesses, tesselated pavements, monuments, &c. The inferior kinds are used for ordinary building purposes, and for road-making. Some varieties even of the soft kind are said to possess the properties of firestone, and to stand exposure to the weather.*

ON THE APPLICATION OF ELECTRO-MAGNETISM TO LOCOMOTIVE ENGINES.

This interesting invention by Messrs. Amberger, Nickles, and Cassoli, has made the subject of a memoir by Mr. G. Love, C. E., presented to the Society of Civil Engineers of Paris in the course of last June. A discussion was immediately opened upon the subject, a detailed account of which was given at the time by the *Annales des Chemins de Fer*, and the *Journal des Chemins de Fer*. The communication was received with feelings of great interest by many of the members present, but three of the engineers opposed strongly the memoir, so far even as to deny altogether facts which the author and many others had been, for a long time, accustomed to look upon as established. In consequence of this Mr. Love felt himself obliged to submit to the society another memoir, in which he investigated more completely the facts previously disputed. The effect of this new memoir was such as the author wished to produce, viz. to determine one of those engineers whose high position on railway working lines should allow it, to take the invention in hand and try it on a large scale. Mr. Sauvage, an eminent government engineer, who has the management of the locomotive department on the Paris and Lyons railway, kindly offered the inventors the means of putting their invention to the test of experience, and they have now been engaged for upwards of a month in preparing the apparatus and engine, with which a decisive experiment will shortly be tried.

The principal object of this notice is to give an abstract of the last memoir; with the hope it may induce practical men to look candidly on the new invention, which seems to us to promise, even in its infancy, to bring important changes in locomotive engines, and also in the construction of railways.

* To be continued.

Amongst the objections made to the first memoir was one which, if it had been true, would have proved the impracticability of ever using electro-magnetism to increase the adhesion of the working wheels of a locomotive engine. It may be useful to remind our readers here in a few words, that the invention consists in a long wire of copper, clothed with silk, and so disposed as to make a great number of circumvolutions round the lower part of the wheel without touching it. When a current of electricity produced by a battery of Buntsen is allowed to run through this wire, or *coil*, the part of the wheel which comes in contact with the rail is transformed into an artificial load-stone, the well-known property of which is to adhere strongly with iron. This in consequence produces an increase of adhesion, the value of which, it is easily understood, can be varied at liberty, according to circumstances. The same battery, when not used to give adhesion, may be turned to act on an iron break, which comes down on the rail like that of Mr. Laignel, and produces powerful friction without the least combination of levers or gearing. A break made on that principle has been lately adapted to a waggon of the Great Western Railway, and it was a matter of no little astonishment to witness the force it displayed, although a very small part of it was touching the rail on account of it being rather out of shape. Now the objection alluded to was this: the wheel electro-magnetised being in contact with an indefinite length of rails, and these touching the earth by a great number of points, there will be a loss of fluid, such as to reduce nearly to nothing the increase of adhesion; or a most powerful battery, and consequently a very large expense, will become necessary to increase it to an efficient and useful degree. This, however, Mr. Love showed to be wholly unsound. We proceed to give a short account of the other objections, which were, in the whole, a mere denial of the following propositions:—

1st. The adhesion of locomotive engines is frequently insufficient. It is not in proportion with their power.

The maximum of adhesion generally corresponds to the greatest effort the engine is capable of producing at the circumference of the driving-wheels, and it is calculated to be about the one-fifth of the weight incumbent upon these wheels. But we know well this quantity of adhesion may, according to the state of atmosphere, go down so low as to become only the one-fifteenth or even the one-thirtieth of the said weight, so that the quantity of adhesion the engine can *provide* varies within considerable limits, entirely out of the control of the engine-man. Now the adhesion the engines *must provide* varies also within tolerably extensive limits, according to the weight of the train, the speed, and the degree of inclination of gradients. Hence, we understand, that it may occur, and indeed it does occur frequently, that the engine can only dispose of a very small quantity of adhesion when the maximum should be required, a circumstance which creates delays, collisions, and at least puts the companies frequently to the extra expense of auxiliary or pilot engines.

Here we find in the memoir a table in which the author gives numerous instances of engines belonging to French railways, with the necessary quantities of adhesion they require on a gradient of 1 in 200; in consequence of their usual speed and the weight of the trains they are calculated and frequently called upon to drag. He has placed opposite the quantities of adhesion, *maxima* and *minima*, these engines can provide according as circumstances are favourable or not, and it is shown by this table that the *required quantity* of adhesion is often double of the quantity that an engine can dispose of.

The conclusion that may be drawn is, that an engine cannot be held to possess a sufficient quantity of adhesion unless her *minimum* should be equal to the *maximum* she may be called upon to provide. It is evident that an engine placed in such a condition might do her full duty in spite of the slippery state of the rails caused by the fog or rain, or other circumstances. But it is equally evident, that such a result could not be aimed at, unless her weight should be increased enormously, far beyond what may be necessary for the strength of her pieces.

2ndly. The insufficiency of adhesion is one of the causes of the limitations of the gradients in the construction of railways.

The power of an engine is such that it would enable her to climb up very steep gradients, provided the speed should vary properly in an inverse ratio; but it must be observed that the steeper the gradient is the greater must be at the same time the necessary *quantity* of adhesion, so that this quantity draws nearer and nearer the maximum the engine can dispose of in the most favourable circumstances, as the gradient goes on increasing. But we know very well that the only quantity to be depended upon is her *minimum*. It insures that increasing the steepness of gradients is increasing in a great proportion the chances of stoppages, collisions, or extra expenses of auxiliary engines, inconveniences that a wise engineer will avoid as much as possible in reducing the gradients, and making tunnels or deeper cuttings, &c.

3rdly. Electro-magnetism taking away all uncertainty on the quantity of adhesion that may be obtained to meet what may be required at any time, will be the means of adopting steeper gradients, and, consequently, of reducing considerably the cost of railways.

This requires no further demonstration: we shall content ourselves with this remark of Mr. Love, that many secondary lines, where speed is not so much wanted, and which could never be thought of being undertaken before, will be easily made with very little expense compared to what should have been necessary with the limited gradient now adopted on most railways.

4thly. Electro-magnetism may also be of great service to lines opened to traffic.

We can see at once, for instance, that the connecting rods of coupled engines, which are in the eyes of all practical men a bad and dangerous system for obtaining the necessary degree of adhesion, will be done away with. There will be no longer any necessity either to fix, in bad weather, those barbarous and absurd sand-boxes in front of the driving-wheels, which, if they get by these means the adhesion required, project the sand into all parts of the mechanism, and wear it out rapidly. Besides, coupling being dropped entirely, companies will soon find a good saving in the maintenance of the roads, which, every body knows, suffer a good deal from that system. Another cause of rapid destruction of the roads, and breakage of rails, is the enormous weight that acts on the driving-wheels. With electro-magnetism weight being no longer a necessary condition for adhesion, that of an engine will be distributed as equally as possible on the three pairs of wheels, and besides the advantages derived from thence for the maintenance of roads, it will permit engineers to limit themselves, in future, to rails of moderate size and weight.

5thly. The principle by which adhesion is now obtained is the most serious obstacle to a more extensive application and improvement of railways and locomotive engines.

Indeed, what sort of improvement may be wished in the new system of roads? One of such a nature as would permit the application of them to those countries, the hilly constitution of which threatens them with being deprived of railways for ever; and we see at once that this desirable object can only be attained in making *cheap railways*, and cheap railways can only be made with *steep gradients* and *light rails*: and who does not perceive that the present *uncertainty of adhesion* and the *enormous weight presently required* on the driving-wheels, is a complete bar to that progress?

Again, what improvement should be looked for in locomotive engines? It would be very desirable that an engine could produce a less costly power, that its weight should be reduced a great deal. But the principle of adhesion is such, that it forbids altogether to seek for the means of diminishing the weight of engines and *profit of an invention* that would

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